# The Potential of Precision Surface Irrigation

## in the context of the Indus Basin Irrigation System


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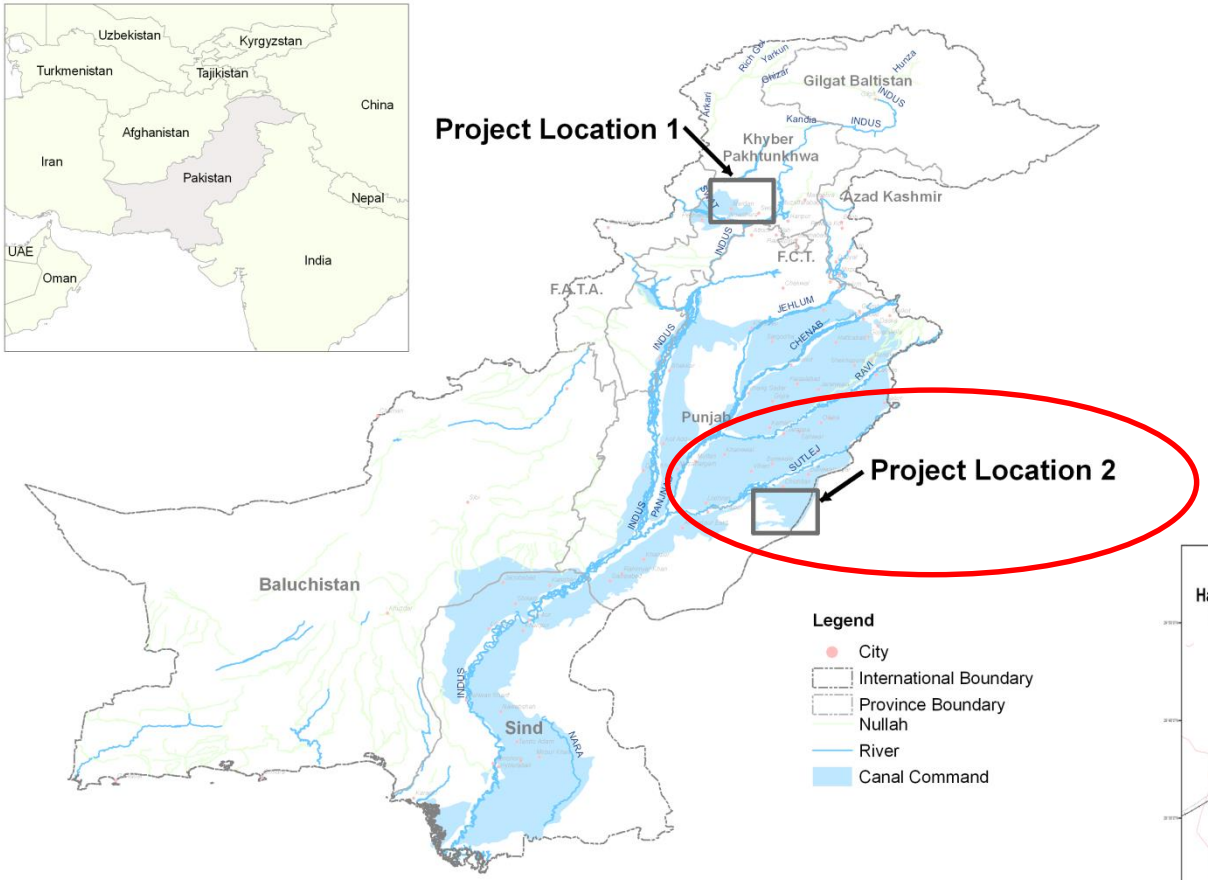
# What is "PRECISION SURFACE IRRIGATION"

- Apply physical sciences/mathematics to surface irrigation (flood irrigation)
- Matching field length, width, slope, soil properties to discharge and irrigation duration
- Maximize distribution uniformity and application efficiency (possibly)

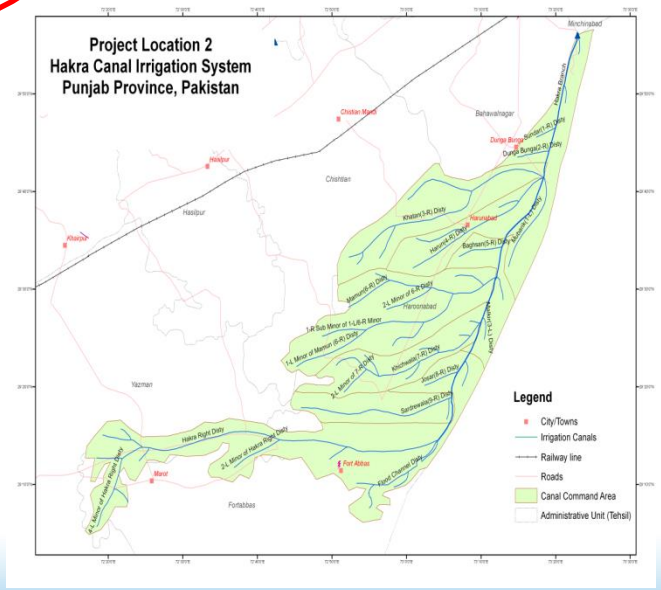
## …… "in the context of the Indus Basin Irrigation System"

- Managed through *warabandi*
- Characterized by a gravity system with limited storage
- Inadequate-by-design i.e. water is inadequate to irrigate the entire area characterized by cropping intensity less than 100% in each season
- Rationing of water typically pro-rata with area
- Land ownership has significant social and cultural value, inheritance is enshrined in culture and religion and difficult to re-engineer.

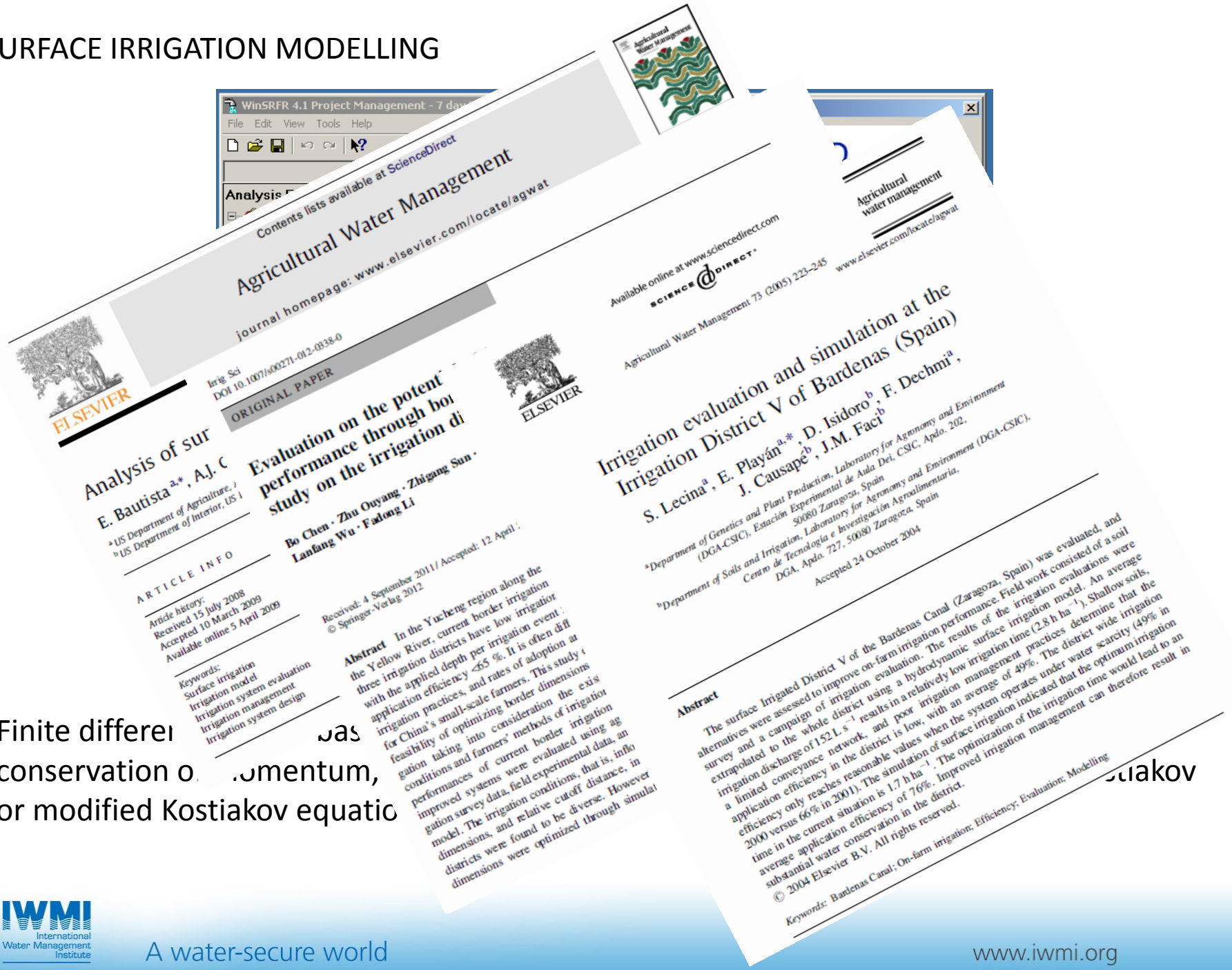
# Materials and Methods




## HAKRA BRANCH CANAL

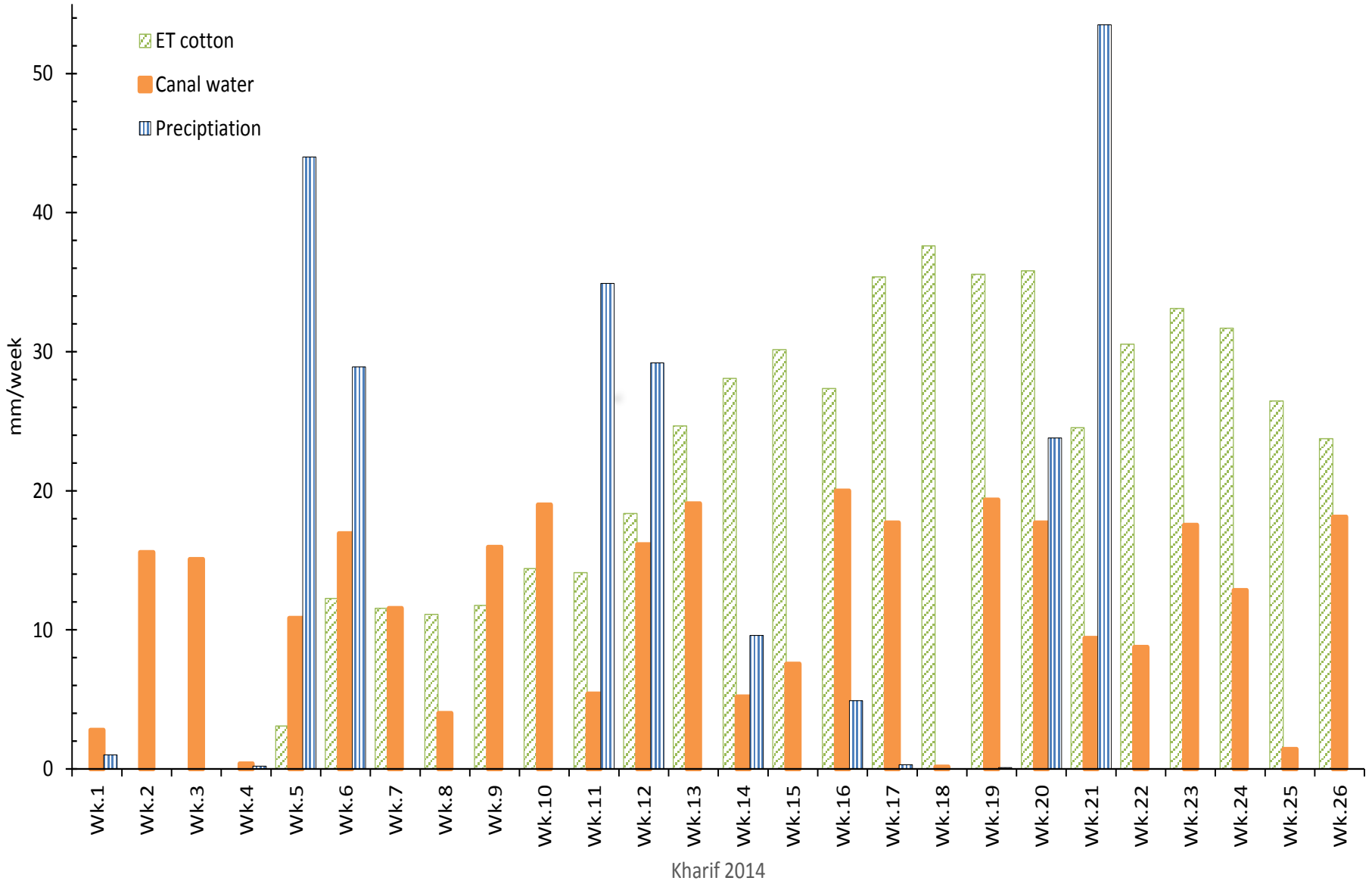


# SURFACE IRRIGATION MODELLING

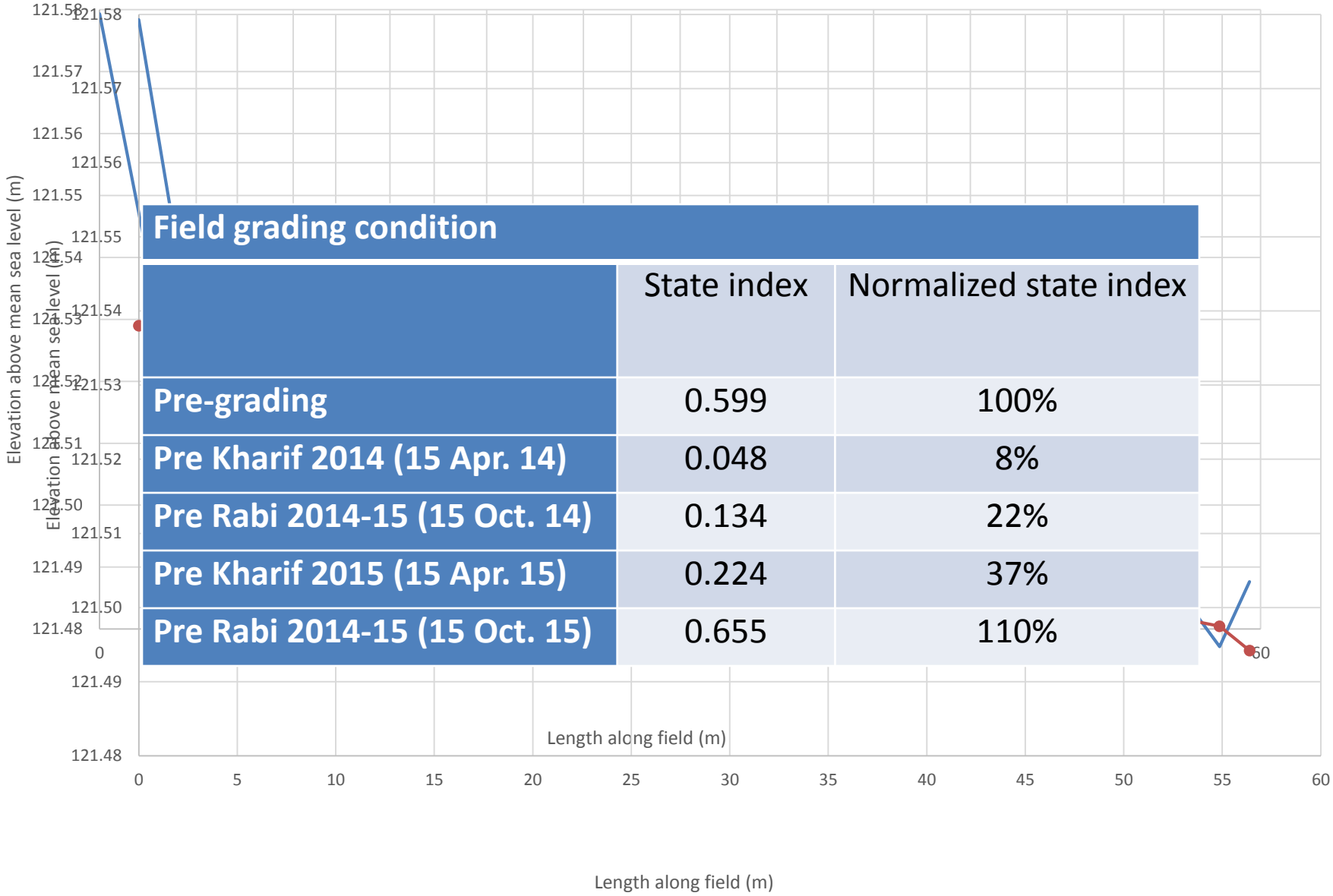



Finite differe bas
conservation o omentum, stiakov
or modified Kostiakov equatio

| Field and water characteristics | | | | |
|---|---|---|---|---|
| **Parameter** | **Furrow irrigation** | | **Border strip irrigation** | |
| | Canal water | Groundwater | Canal water | Groundwater |
| **Length** | 54.80m | | | |
| **Total width** | 67.07m | | | |
| **Field area** | 0.37ha | | | |
| **Discharge** | 55 $Ls^{-1}$* | 20 $Ls^{-1}$ | 55 $Ls^{-1}$ * | 20$Ls^{-1}$ |
| **Cutoff time** | 47 min $ha^{-1}$ | Farmer | 47 min $ha^{-1}$ | Farmer |
| **Irrigation frequency** | Weekly | Farmer | Weekly | Farmer |
| **Furrow set size** | Farmer | Farmer | - | - |
| **Border strip width** | - | - | Farmer | Farmer |
| **Cropping intensity** | Farmer | Farmer | Farmer | Farmer |
| *** but can vary significantly** | | | | |


ET cotton
Canal water
Preciptiation
mm/week
0
10
20
30
40
50
Wk.1
Wk.2
Wk.3
Wk.4
Wk.5
Wk.6
Wk.7
Wk.8
Wk.9
Wk.10
Wk.11
Wk.12
Wk.13
Wk.14
Wk.15
Wk.16
Wk.17
Wk.18
Wk.19
Wk.20
Wk.21
Wk.22
Wk.23
Wk.24
Wk.25
Wk.26
Kharif 2014

International
Water Management
Institute

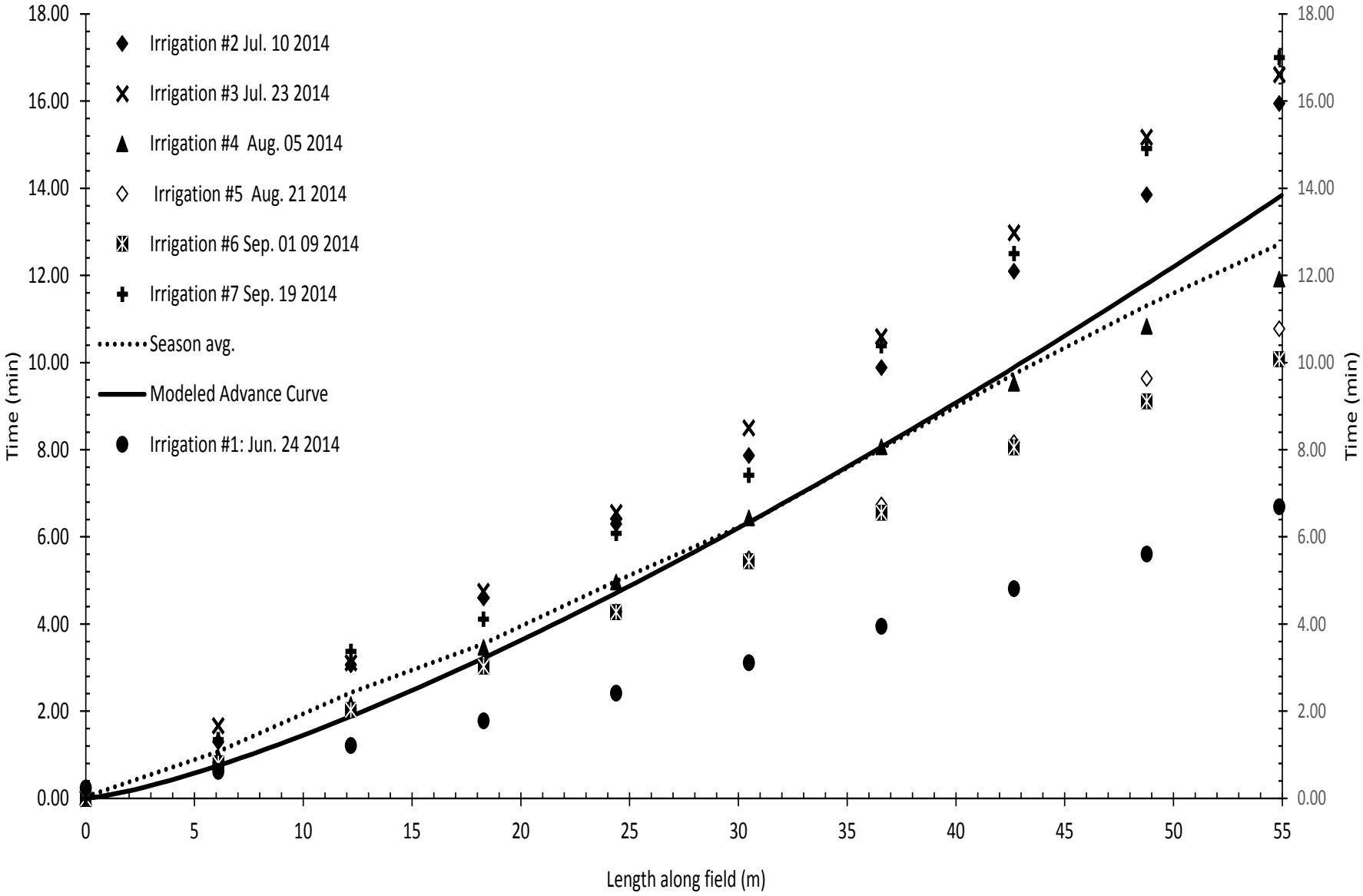


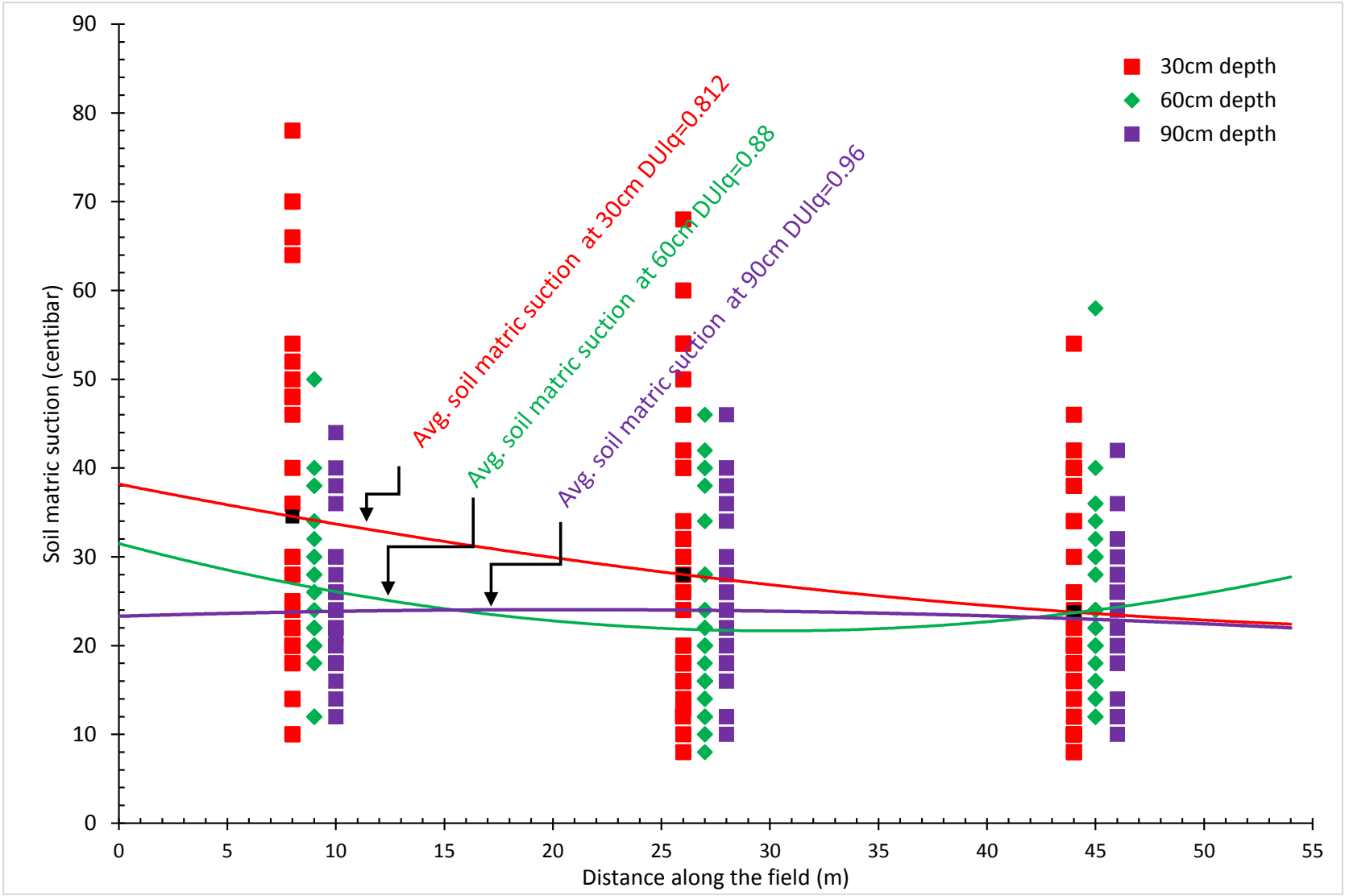

| Field grading condition | State index | Normalized state index |
|---|---|---|
| Pre-grading | 0.599 | 100% |
| Pre Kharif 2014 (15 Apr. 14) | 0.048 | 8% |
| Pre Rabi 2014-15 (15 Oct. 14) | 0.134 | 22% |
| Pre Kharif 2015 (15 Apr. 15) | 0.224 | 37% |
| Pre Rabi 2014-15 (15 Oct. 15) | 0.655 | 110% |

Length along field (m)

| Performance indicators of furrow irrigation with canal water irrigation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Fallow area** | Cropping intensity | Cutoff time (hrs) | Furrows | $d_{lq}$ (mm) | Low quarter distribution uniformity | Potential application efficiency | Completion of advance time (hrs) | Cutoff ratio |
| **0%** | 100% | 0.63 | 92 | 25 | 0.826 | - | 0.53 | 1.18 |
| **10%** | 90% | 0.63 | 83 | 32 | 0.930 | - | 0.46 | 1.37 |
| **20%** | 80% | 0.63 | 74 | 37 | 0.957 | - | 0.39 | 1.61 |
| **30%** | 70% | 0.63 | 64 | 44 | 0.979 | - | 0.33 | 1.93 |
| **40%** | **60%** | **0.63** | **55** | **51** | **0.991** | **97%** | **0.27** | **2.31** |
| **50%** | 50% | 0.63 | 46 | 61 | 0.992 | 81% | 0.23 | 2.81 |

| Performance indicators of furrow irrigation with groundwater irrigation | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Furrow sets** | Furrows per set | Potential application efficiency | Low quarter distribution uniformity | Completion of advance time (hrs) | Cutoff time (hrs) | Cutoff ratio | Irrigation time (hrs) |
| **1** | 55 | 90% | 0.905 | 1.21 | 1.88 | 1.56 | 1.88 |
| **2** | 27, 28 | 98% | 0.986 | 0.40 | 0.84 | 2.09 | 1.68 |
| **3** | **18, 18, 19** | **98%** | **0.984** | **0.25** | **0.56** | **2.26** | **1.68** |
| **4** | 13,14,14,14 | 97% | 0.979 | 0.19 | 0.56 | 2.28 | 1.76 |


Irrigation #2 Jul. 10 2014
Irrigation #3 Jul. 23 2014
Irrigation #4 Aug. 05 2014
Irrigation #5 Aug. 21 2014
Irrigation #6 Sep. 01 09 2014
Irrigation #7 Sep. 19 2014
Season avg.
Modeled Advance Curve
Irrigation #1: Jun. 24 2014
Time (min)
Length along field (m)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
0
5
10
15
20
25
30
35
40
45
50
55




Increase in cotton productivity per unit of water by 10%

Increase in cotton productivity per unit of land by 11%


نمانشی پلاٹ
WWF
Promotion of Agriculture Water Stewardship
in Cotton Growing areas of Punjab, Pakistan
بہتر امور (BMP) برائے پانی کی بچت، لیزر لیولنگ، کھیتوں پر کاشت
ڈبلیو ڈبلیو ایف پاکستان، بہاولپور
فون نمبر: 062-2888314, 2882119

# CONCLUSIONS

- Precision surface irrigation can be applied to the highly constrained irrigation environment of the Indus Basin Irrigation System with a some degreeof success.

- Laser grading is achievable at relatively modest cost and the improvement in the field profile will last for over two years with two crop-season per year although this is less than the four years in the literature.

- Adjusting the cropping intensity and furrow sets it is possible to obtain very high performance of surface irrigation both under canal water and under groundwater which would meet crop water requirements.

- With border strip irrigation it is much more challenging to obtain reasonable performance with either canal water or groundwater.

- With the weekly schedule of the *warabandi* the required depths of water are rather too small to apply with any degree of efficiency

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The study design, data collection, analysis and interpretation of the results are exclusively those of the authors.


**THANK YOU**

**QUESTIONS?**